Truth or Consequences: A feminist critical policy analysis of the STEM crisis

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Abstract:

STEM education has received significant attention in the USA and is largely fueled by rhetoric suggesting the USA is losing its global competitive edge and that there is a lack of qualified workers available to fill growing STEM jobs. However, a counter discourse is emerging that questions the legitimacy of these claims. In response, we employed feminist critical policy analysis as both a theory and a method to further critique the STEM crisis discourse. We argue that the nature of the current discourse is misleading at worst and incomplete at best and show who is fueling the crisis discourse and who stands to win or lose as a result. We reveal how the crisis discourse draws attention away from the multi-layered complexity of the issue and surface what is missing in the discourse to re-center public attention on protracted problems that still need dismantling.

Keywords: qualitative research methods | critical policy analysis | feminist theory | STEM | women and girls in education

Article:

Truth or Consequences was an American radio and TV game show popularized in the 1950s by Ralph Edwards, which featured contestants meeting "consequences" if they did not answer posed questions truthfully. What made the show doubly entertaining were the questions, which were always impossible to answer, along with the consequences, which consisted of silly and embarrassing stunts, much to audiences' delight. Similar to the decades-long classic game show, the STEM crisis discourse began in the 1950s and finding truth seems just as elusive. However, unlike the comical game show, the consequences of public deception, in the form of rhetorical tropes surrounding the STEM crisis discourse, are anything but amusing, and in some cases, quite serious.

Following Marshall's (1997) lead advocating for a dismantling of traditional policy analyses, we have chosen to consider the current STEM policy discourse from a critical feminist perspective.

We pose the question: How well are women and minoritized others faring as a result of the current STEM discourse? Unlike the game show, the question is not impossible to answer, but our analysis does uncover conflicting truths. Despite largely well-intentioned efforts to actually provide more opportunities for women and minoritized others to be successful in the STEM fields, progress has been slow (Leaper, Farkas, & Brown, 2012). Reasons for this include: (1) embedded within the discourse are bureaucratic and patriarchal notions of "innovation," (2) policy solutions are being implemented that do not attend to the underlying social, economic, and political complexities that shape the lives of women and minoritized groups, and (3) the solutions rely on a contested problem definition couched in terms of a "crisis" that relies on a male-normed, competitive context of "winning races," "being left behind," and forestalling a "national economic disaster." The traditionally male-dominated fields of science, technology, engineering, and mathematics provide a rich gender-segregated backdrop against which dominant values clearly continue to constrain certain students' educational choices and outcomes. Issues of so-called "leaky" talent pipelines, incompetent teachers (largely women), inferior students (women and minoritized others), inadequate, weak curricula, and international rivalry fuel this debate.

In this article, we argue that the nature of the STEM crisis that is promoted in the public sphere is misleading at worst and incomplete at best. In addition, we aim to show who is presently fueling the crisis discourse and who stands to win or lose as a result. We also reveal how the popular crisis discourse draws attention away from the multi-layered complexity of the topic. In addition, we surface what is missing in the discourse to re-center public attention on protracted problems that still need addressing. In so doing, we show the utility of a feminist critical policy framework, but we do not offer this analysis as the "Truth." Rather, we aim to share an account that is less false and less limited while also providing a more complex and comprehensive discussion (Olesen, 2005).

Theory and methods

Theoretical underpinnings

The literature distinguishes between traditional and critical forms of policy analyses. The traditional approach is described by some as a linear process devoid of value judgments that focuses on measureable phenomena – free of power struggles – that can be analyzed within the contexts of educational program design and policy implementation by scientific application of theory and methodology (Birkland, 2005; Fischer, 2003; Rochefort & Cobb, 1994). According to Fischer (2003), the policy analysis field emerged as more of a technocratic rather than democratic arena shaped by a limited methodological framework of "neopositivist/empiricist methods" that disregarded a multidisciplinary approach (p. 4). Thus, some scholars believe traditional analysis lacks sophistication by ignoring the contestable nature of problem definition, research findings, and explanations and arguments for solutions (Blackmore, 1995; Fischer, 2003; Marshall, 1999). Therefore, other tools are necessary, drawing from many disciplines while considering the contributions of critical theory, post-structuralism, social constructionism, postmodernism, and discourse analysis to get at the heart of how policies that seem neutral on the surface actually act to reify discriminatory practices for historically marginalized populations (Fischer, 2003; Rochefort & Cobb, 1994).

Feminist critical policy analysis

Feminist critical policy analysis (FCPA) builds on the philosophical underpinnings of the critical approach, but concurrently narrows and expands its purposes by focusing on the effects of policy on women and insists on "producing new syntheses that in turn become the grounds for further research, praxis, and policy" (Olesen, 2005, p. 236). Marshall and Young (2005) would agree and call for the use of more "assertive methodologies" that enable analysts to uncover how society constructs gender- and power-based hierarchies in employment, families, religions, schools, businesses, and politics. Like other critical frameworks, the feminist approach does not hide the fact that it comes to the research situation with feminist values in mind. Another commonality with other critical approaches is its use of discourse analysis to uncover ideologies and assumptions embedded in policy documents, as well as its goal of identifying formal and informal power, politics, and policies that help or hinder human experience (see Eyre, 2000; Marshall, 2000; Parsons & Ward, 2001). Ideas from critical and poststructuralist work are often woven together to inform research questions, arguments, and proposed methodologies.

The purpose of FCPA is to show how numerous policies appear to be gender-neutral on the surface, but in fact, negatively impact women. The approach generally asks how gender, race, and class shape the entire policy process and specifically asks how women are "represented, reproduced, regulated and restrained" (Pillow, 2003, p. 151). Values of feminist theory are embedded in policy analyses such as mutuality, cooperation, shared power (Ferguson, 1993; Gilligan, 1982/1993; Lorde, 1984; Marshall, 1997), and what Sara Ruddick called, "The Politics of Peace" (1989). Feminist research explores a variety of themes including: power, discrimination, stereotyping, objectification, oppression, patriarchy, capitalism, and economic exploitation with a focus on ending the subordination of individuals based on class, ethnicity, race, age, gender, and sexual orientation (Anzaldúa, 2007; Bensimon, 1997; Lorde, 1984). Feminist projects also give voice to the public–private/male–female divide, respectively, and the ways in which power inequities are created and/or reinforced in society and in scientific and academic institutions (Ferguson, 1984; Frazer, 1989; Harding, 1986, 2006; Lather, 1991; Marshall, 1997). "The imperative for feminist policy analysts is clear: they must reinvent their methods and theories as if women mattered" (Mawhinney, 1997, p. 237).

Identity intersectionalities

As alluded to above, feminist analysis is complicated by the complexity of categories such as gender and race. This is exemplified by the following quotes: "While struggling to 'write against the grain,' feminist analysts also have to address assertions that their work has race, class, and heterosexual biases" (Marshall, 1999, pp. 69–70). "Feminists love to hate essentialism, to track it down in its various places, to identify its disguised reproductions, to ferret it out in fellow feminists, and to assure ourselves that we are not committing its sins" (Ferguson, 1993, p. 81). As Blackmore (1997) explains, "there are instances when we need to universalize the experience of women across culture, race, class and time; and other instances when we need to emphasize specificity and difference amongst women in different contexts" (pp. 441–442). Rather than lament this as a negative manifestation of division among women, Blackmore (1997) advises us to consider it a process of articulating "between the macro and the micro: the particular and the universal" (p. 442), depending on the situation.

The bottom line for this paper is to acknowledge the difficulties and press for research designs that center on arenas of power and dominance such as school boards and legislative bodies along with policy artifacts such as curriculum guides (Marshall, 1999). Meanwhile, one must be sensitive to what Olesen (2005) describes as the "failure to attend closely to how race, class, and gender are relationally constructed leav[ing] feminists of color distanced from feminist agendas" (p. 236). Harris (2000) would agree, criticizing feminist legal theory as "mostly white, straight, and socioeconomically privileged" and that which "paves the way for unconscious racism" (p. 263). This is not to say that the feminist community does not mean well, but it is to say that some feminists assume the condition of women, regardless of other identity complexities, to be essentially the same and thus speak in an overarching voice that mistakenly speaks for all. The fact that the current social structure works for some women and not for others is not adequately problematized (Delgado, 2000; Harris, 2000). Accordingly, this research aims to go beyond gender by considering race and socioeconomic status rather than ranking gender above race or other characteristics. Thus, Blackmore's (1997) call to purposely fluctuate between micro and macro emphases as context permits or requires is a challenging, yet vital strategy.

Methods

CPA scholars use a variety of data sources in their work from interviews to data-sets but tend toward qualitative methods because they dovetail with a critical approach to conducting research (Young, Diem, Lee, Mansfield, & Welton, 2010). In the case of this project, data sources included policy artifacts or the objects, language, and acts that make up a policy and the means by which the policy is communicated to various publics (Yanow, 2000). Policy artifacts included policy documents as well as websites and news outlets that illumine discourse amongst various communities of meaning (Yanow, 2000) amongst state and national political and educational groups including: White House Initiatives and state departments of education.

We began with an examination of historical documents at the national level to understand and communicate the activation and development of the STEM crisis discourse. In an effort to understand how the STEM policy discourse at a macro level impacts how policies were then interpreted and enacted at the micro level, we chose to focus on the STEM policies of the three states in which we work: California, Illinois, and Virginia.

Documents collected from national and state archives were then analyzed using the constant comparison method (Mertens & Wilson, 2012; Miles & Huberman, 1994). We engaged a fluid process of analysis and interpretation, whereby we constantly collected data, made sense of them, and then revisited analysis of data in light of new findings and conversations with each other. This non-linear, circular process proceeded akin to a dialogue between the researchers and the data (Wolcott, 1994).

Following a process outlined by Lawrence-Lightfoot and Davis (1997), we conducted "open coding," which entailed reading copies of documents line-by-line to note consistent themes or story lines. We then enlarged the account by identifying key concepts and their interrelationships while keeping in mind federal and state contexts. We then implemented "focused coding" that consisted of additional readings of the data to carefully filter initial impressions via the lens of FCPA. Eventually, key ideas were grouped into broader topics, referred to by Yanow (2000) as "policy frames" and Lawrence-Lightfoot and Davis (1997) as "repetitive refrains."

In addition, we consulted the slim body of academic dialogue that has questioned the legitimacy of the STEM crisis discourse (Anft, 2013; Barias, 2006; Charette, 2013; Feuer, 2011; Ramirez, 2007; Schalin, 2012a, 2012b). The information gleaned from these sources, as well as conversations with fellow scholars at research conferences, led us to further investigate statistical documentation of job creation and career trajectories from sources such as the US Department of Labor (US Bureau of Labor Statistics, 2012a, 2012b; US Department of Commerce, 2011, 2012). Thus, a variety of sources such as policy documents, the research literature, and labor statistics acted as a form of triangulation in the case of this project.

Federal discourse and initiatives

As a first step toward troubling the policy discourse on the STEM crisis, we felt it was important to examine the history of the discourse at the federal level. We found there were three time periods in which there was an emphasis on the STEM crisis at the federal level in terms of quantity of messages as well as resources backing those messages at the highest levels.

The 1950s and 1960s

The "STEM crisis" can be traced back to the "Sputnik Crisis" in the 1950s that spurred the development and enactment of The National Defense Education Act (NDEA) in 1958 by President Eisenhower. The intention of NDEA was to counteract the growing national concern that schools in the former Soviet Union were surpassing US schools and thus, US scientists could not compete with Soviet scientists. The policy was also a response to the advent of the electronic computer and the acute shortage of mathematicians needed as programmers to supply this nascent, but burgeoning field. Coupled with the billions of dollars that were infused into the US education system via NDEA were several other government programs designed to beef up research and development in the Department of Defense, which eventually led to the establishment of the Defense Advanced Research Projects Agency and the National Aeronautics and Space Act. Federal support for the National Science Foundation (NSF) also increased dramatically during this period.

An additional development in the 1960s was the Elementary and Secondary Education Act (ESEA) of 1965 designed to allocate funding to support the needs of educationally deprived children. The rhetoric surrounding ESEA was also tied to the "Sputnik Crisis" by emphasizing the need for "compensatory education" to ensure poor and minority students could also attain Sputnik-inspired academic objectives (ESEA, 1965).

The 1980s

The crisis language continued at varying intensities throughout the next two decades, leading to a watershed moment in 1983 with the publication of *A Nation at Risk*. The report was presented to the US Secretary of Education by members of the National Commission on Excellence in Education (NCEE). Composed of governors, school board members, school principals, university professors, and schoolteachers, NCEE warned in no uncertain terms:

> Our Nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world … If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves. We have even squandered the gains in student achievement made in the wake of the Sputnik challenge … We have, in effect, been committing an act of unthinking, unilateral educational disarmament.

The report recognized several factors as evidence of the "intellectual, moral, and spiritual" incompetence that would lead not only to material loss, but to democratic disenfranchisement, including: an adult illiteracy rate of 23 million and student achievement on standardized tests being "lower than 26 years ago when Sputnik was launched." Additionally, these deficits coincide with the changing demands of a workforce centered on technology such as computers, robotics, and other industrial equipment, requiring an ever more educated workforce (National Commission on Excellence in Education, 1983).

Shortly thereafter, in 1984, the Perkins Act was updated with the aim to boost the quality of technical instruction in US schools to ultimately augment the US economy and was renamed, the Carl D. Perkins Vocation and Technical Education Act. The law was then reauthorized in 2006 under President Bush as the Carl D. Perkins Career and Technical Education Improvement Act of 2006. The 2006 changes included using terms such as "career" and "technical" rather than "vocational" and required educational programs to integrate technical content across the curriculum. The new Perkins Act also provided over one billion dollars for technical education and integrated career pathways programs in all 50 States (Perkins Act, 2006).

The early twenty-first century

Coinciding with the updated Perkins Act (2006) is the 2006 *American Competitiveness Initiative* (ACI) spearheaded by President Bush. Recognized as "an aggressive, long-term approach to keeping America strong and secure," the ACI's overall goals include forefronting science and technology as keys to "America's long-term competitiveness" and ensure that "the United States continues to lead the world in science and technology" (ACI, 2006). The goals of ACI include: securing 10,000 more scientists, technicians, and graduate students to participate in "innovation enterprise"; providing 100,000 "highly qualified math and science teachers by 2015"; helping 800,000 workers get the skills "they need for the jobs of the twenty-first century"; pledging 300 grants to schools that implement "research-based math curricula and interventions"; and ensuring 700,000 low-income students pass advanced placement tests (ACI, 2006).

The goals of President Bush's ACI were translated into congressional legislation in 2007 as the *America **C**reating **O**pportunities to **M**eaningfully **P**romote **E**xcellence* *in **T**echnology, **E**ducation, and **S**cience **A**ct* (America COMPETES). This bipartisan effort is a three-pronged approach: doubling research funding for programs in physical sciences to include nanotechnology, supercomputing, and alternative energy sources; authorizing new, research-based math programs and professional development for teachers to improve elementary and middle school student achievement; and expanding low-income students' access to Advanced Placement/International Baccalaureate (AP/IB) coursework via expanding training for teachers in high-need schools (America COMPETES, 2007).

In 2009, President Obama spoke at the National Academy of Sciences promising a national campaign designed to, "raise American students 'from the middle to the top of the pack in science and math over the next decade'" (White House Brief, 2009). Shortly thereafter, the "Educate to Innovate" Campaign was launched to do just that. His commitment to raising the level of STEM education to a "national priority" included speaking to "key leaders" in STEM and crafting "high-powered" partnerships and commitments by philanthropic organizations described as "dramatic" due to the promise of $260 million in financial and in-kind support (White House Brief, 2009). This coalition of big names includes the Carnegie Corporation of New York and the Bill and Melinda Gates Foundation with the goal of applying, "new and creative methods of generating and maintaining student interest and enthusiasm in science and math, reinvigorating the pipeline of ingenuity and innovation essential to America's success that has long been at the core of American economic leadership" (White House Brief, 2009). Additional goals include: increasing STEM literacy so all students can think critically in science, math, engineering, and technology; improving the quality of math and science teaching so American students are no longer outperformed by those in other nations; and expanding STEM education and career opportunities for under-represented groups, including women and minorities:

> The President's $4.35 billion Race to the Top fund provides a competitive advantage to states that commit to a comprehensive strategy to improve STEM education … by raising standards, using data to improve decisions and inform instruction, improving teacher effectiveness, using innovative and effective approaches to turn around struggling schools and making it possible for STEM professionals to bring their experience and enthusiasm into the classroom. These reforms will help prepare America's students to graduate ready for college and career, and enable them to out-compete any worker, anywhere in the world. (White House Brief, 2009)

Finally, the Obama Administration made clear that "Race to the Top" grants would go to those committed to improving STEM education.

In addition to expanding the pipeline to people of color, the White House Office of Science and Technology Policy (n.d.) also stated their commitment to expanding opportunities for girls and women in the STEM fields:

> Supporting women STEM students and researchers is not only an essential part of America's strategy to out-innovate, out-educate, and out-build the rest of the world; it is also important to women themselves. Women in STEM jobs earn 33% more than those in non-STEM occupations and experience a smaller wage gap relative to men.

In collaboration with the White House Council on Women and Girls (2011), the goals of The Office of Science and Technology Policy (n.d.) include: increasing the engagement of girls with STEM subjects in schools and informal settings; encouraging mentoring to support women throughout their academic and professional experiences in STEM fields; and supporting efforts to retain women in the STEM workforce.

Development and implementation efforts at the state level

In addition to examining the policy context and discourse related to STEM at the federal level over time, we felt it was important to also examine examples of efforts at the state level. For the purposes of this paper, we have limited our examination of the discourse to California, Illinois, and Virginia. Themes that emerged in our examination of state-level implementation efforts included: needing a competitive workforce; a lack of federal support to back federal rhetoric; and a push to standardize state college and career readiness initiatives.

Workforce needs and a competitive edge

All three states seem to take their lead from the federal crisis discourse by staging a STEM calamity, suggesting that there is a limited workforce with the skills and education necessary to maintain a competitive edge – globally and nationally – in the STEM fields. Discussions related to job growth in the STEM sector and the need to use this growth to emerge from the economic crisis, and instead head towards economic recovery, seem to drive the educational policy agenda in all three states. There is concern that the educational pathway to the *American Dream* has changed significantly, pointing to the need for postsecondary education to secure available jobs (Carnevale, Smith, & Strohl, 2010). Since California, Illinois, and Virginia have specific economic and commercial needs that closely tie with the advancement of the STEM preparation pipeline, each state's policy rhetoric goes to great lengths to justify why developing a skilled workforce in STEM is necessary for the state's economic viability.

For example, STEM-related industries are a major economic component in California's economy. Yet, in order to maintain an "innovation-driven economy in the twenty-first century, our students must be equipped with the skills and experiences that will prepare them to be leaders in our state's robust economy and diverse, complex society" (California STEM Learning Network, 2012). Even though California is a major hub for STEM-related industries, California students lag behind other states in math and science proficiency, with dramatic achievement and opportunity gaps among California students. While California used to be a national leader in K-12 and higher education, it now ranks 43rd or lower among all states in mathematics and science proficiency in grades 4 and 8. The education system that once helped propel California's innovation-based economy is losing momentum (California STEM Learning Network, 2012).

Similarly, Illinois believes there will be demand for over 319,000 STEM jobs by 2018 and 93% of these jobs will require some form of postsecondary education and training (Illinois Department of Commerce and Economic Opportunity [IL DOCEO], 2012). Illinois will need a skilled workforce to fill job growth in the STEM fields, thus increasing the "talent pipeline" in the state (IL DOCEO, 2012, p. 11). This talent pipeline shows promise in the early grades, but then significant inequities in accessing postsecondary opportunities cause leaks in the "talent pipeline" within the K-12 settings. Moreover, approximately 70% of Illinois high school graduates start some form of advanced training or education within two years of secondary school completion. However, only 43% of Illinois young adults between 25 and 34 have a college degree (IL DOCEO, 2012). Not only are overall numbers disturbing, but also examining the data in terms of race/ethnicity shows there are also significant racial disparities in this so-called "talent pipeline." For example, in 2006, 50% of White Illinois constituents between the ages of 25 and 34 in the workforce had an associates degree or higher, whereas only 25.4% of African-American and 16.5% of Latina/o constituents had an associates degree or higher (Illinois Board of Higher Education [IBHE], 2009).

The Commonwealth of Virginia has also set a statewide agenda for college and career readiness based on the competitive workforce rhetoric. According to the Virginia College and Career Readiness (CCR) discourse, students are not only facing greater competition for employment on a state and national level, but additionally, students in Virginia are also competing with "candidates around the world as more people in more countries are becoming more highly educated" (VADOE, 2010, p. 3). Also, statistics suggest that employers in Virginia have augmented required credentials and thus, expect their employees have some form of higher education to meet additional workforce standards. Nearly 35 years ago, 12% of jobs in Virginia required postsecondary training, while the current expectation has risen exponentially to 80% (VADOE, 2010). The state also argues that college and career readiness should be a state priority because it benefits the economic well-being of individuals and the state at large: "As a Commonwealth, increasing citizens' educational attainment levels will also lead to economic growth throughout the state – by increasing income and reducing the number of children living in poverty" (VADOE, 2010, p. 3).

Given this compelling need to maintain a foothold in science, California and Illinois joined 26 states in taking the lead on implementing the Next Generation Science Standards (NGSS). NGSS is based on the Framework for K-12 Science Education developed by the National Research Council (Achieve, 2013). Apparently, the framework is more heavily centered on college and career readiness and gives students experiences essential to post-K-12 workforce success. The development of NGSS was spearheaded by Achieve, an independent, nonpartisan, nonprofit education reform organization dedicated to working with states to raise academic standards, increase graduation requirements, improve assessments, and strengthen accountability (Achieve, 2014). According to Achieve, these science standards were developed collaboratively with states and other stakeholders in science, science education, higher education, and industry.

Federal enticement, but limited federal support

All three of our case states submitted a federal *Race To The Top* (RTTT) application. Virginia submitted in the first round, while California and Illinois submitted in both rounds one and two. While California and Illinois were both finalists, only Illinois was awarded $42.8 million in round three. Even though California and Virginia were not awarded RTTT funds, both used state funds to proceed with what they pledged to execute in their RTTT applications.

Since the RTTT application requires the integration of STEM, both Illinois and Virginia established initiatives that would strengthen the P-20 STEM pipeline, improve teacher STEM instruction, and foster partnerships between K-12, postsecondary institutions, and industry. In 2007, Virginia received a grant from the National Governors Association Center for Best Practices. These funds were used to develop criteria for school divisions to implement *Governor's Career and Technical STEM Academies* that would include partnerships with business and industry, public school divisions, community colleges, and where applicable universities, and workforce and economic development entities. Illinois will also use $2.3 million of its RTTT funds to form its own version of STEM partnerships coined the *Illinois Pathways STEM Learning Exchanges*. A STEM Learning Exchange is an innovative public–private education partnership that is organized to support local implementation of P-20 STEM programs of study (POS) including: agriculture, food, and natural resources; architecture and construction; energy; finance; health science; information technology; manufacturing; research and development; and transportation, distribution, and logistics.

Finally, Illinois will use its RTTT funds to align STEM POS (in the nine areas previously specified in the STEM Learning Exchanges) starting from 7^{th} to 12th grade. Districts that serve grades 9 through 12 must create at least two or more POS in STEM. Also, Illinois is working towards developing better transition and credit articulation in STEM at the postsecondary level. The state also wants to ensure every STEM career and technical program at the postsecondary level emphasizes portfolio development through completing degree programs, attaining credentials, and life-wide professional networks.

While these efforts show promise to fulfill the federal push for solving the STEM crisis, many states are left to fend for themselves without federal dollars to support their efforts. The RTTT process acts as the proverbial "carrot and stick" but the competitiveness of the process leaves most states lacking the necessary support to follow through on implementation. Thus, states hoping to bolster their competitive edge must abandon their plans or find alternative means of funding their optimistic initiatives.

Finally, NCLB waivers offer lucrative incentives for non-RTTT recipients such as California and Virginia. Both states are using the waiver to pursue reforms they originally sought to fund through RTTT dollars. NCLB waivers give states relative flexibility from some accountability restrictions only if waivers are accompanied by agreements to design and implement statewide plans to improve educational outcomes for all students, close the achievement gaps, increase equity, and improve quality of instruction (US Department of Education [US DOE], 2013a). Virginia's plan of action for NCLB does focus on one of the STEM areas – math – as well as reading. Unfortunately, this plan of action does not necessarily center on providing more resources and opportunities for students in these content areas but rather, targets the three following "proficiency gap groups" struggling to meet state standards:

1. *Proficiency Gap Group 1* – Students with disabilities, English language learners and economically disadvantaged students, regardless of race and ethnicity;
2. *Proficiency Gap Group 2* – African-American students, not of Hispanic origin, including those also counted in Proficiency Gap Group 1;

3. *Proficiency Gap Group 3* – Hispanic students, of one or more races, including those also counted in Proficiency Gap Group 1.

According to Virginia's statewide plan, getting these proficiency gap groups to pass the Standards of Learning (SOL) test is the sole (and we argue, limited) indicator for successfully closing the achievement gap. Comparatively, California is the first state where individual districts, a total of eight, have been awarded NCLB waivers. These particular California districts include alternative strategies for measuring student success including: social–emotional factors, measures of school climate and culture in addition to standardized test data. However, all reform efforts are narrowly fixed on students with disabilities, English language learners, and low-income students (US Department of Education [US DOE], 2013b).

Standardizing college and career readiness

While California is implementing the Next Generation Science Standards as its main vehicle for college and career readiness, Virginia and Illinois have implemented a variety of other reforms. While the call to standardize is somewhat driven by the need to develop a better skilled workforce in each state, it appears the primary impetus to standardize emanates from policy discourse at the federal level, specifically RTTT and the Common Core.

Illinois, as a RTTT 3 recipient, is required to develop an assessment framework. The Illinois State Board of Education will provide local education agencies (LEAs) with a list of recommended assessment frameworks that aim to: support standards implementation; improve instruction; and measure student growth (IL RTTT application, p. 21). The assessment framework chosen by LEAs participating in RTTT must align with the CCSS and integrate professional development and training in the use of the assessment. RTTT also requires participating LEAs to develop assessments for grade levels and subjects not currently assessed by the state while also following its STEM POS model. The POS assessments must measure students' academic achievement in each STEM-focused career and technical pathway, as well as measure a student's employability.

Similarly, the Virginia College and Career Readiness Initiative (VCCRI) builds upon the state's SOL. VCCRI primarily ensures that: (1) college and career ready learning standards in reading, writing, and mathematics are taught in every Virginia high school classroom; and (2) students' preparation for college and the workforce is strengthened before leaving high school. Additionally, in order to increase student matriculation to any four-year postsecondary institution across the country, Virginia has established indicators that assess the level at which students are college and career ready including: participating in a college preparatory curriculum that includes Algebra II and chemistry; earning advanced proficient scores on mathematics, reading, and writing SOL assessments; and obtaining an advanced studies high school diploma. Other indicators that Virginia uses to determine whether students are ready for credit-bearing courses at a postsecondary institution are: participating in AP, IB, and dual-enrollment courses; participating in the Virginia Early College Scholars program; and earning college ready scores on placement tests such as the SAT and ACT (VADOE, 2010).

Contrary to the crisis rhetoric, Virginia high school students have presented notable gains in STEM fields according to a variety of indicators. The number of students who attempted to take the SAT science portion grew from 2829 in 2004 to 16,809 in 2011. Also, between 2008 and 2011, 63% of high school students enrolled in a career and technical pathway and industry specific exam for certification (VADOE, 2012). However, these data are not presented in a disaggregated format to determine equity across groups.

Overview of overall impact of STEM initiatives and current broad economic indicators

As indicated by the above, the crisis discourse has existed for at least 50 years. Moreover, there has been a steady increase in the attention given to the importance of bolstering participation in the STEM fields. However, it is still questionable whether and how this growing national attention to the STEM crisis has resulted in tangible impact in terms of job creation, STEM career growth, and increased representation of women and racial/ethnic minorities in the STEM fields (or whether or not the crisis discourse is authentic in the first place). While it is too early to assess the impact of the state initiatives fueled by RTTT, we can still take a brief look at some broad indicators and the overall impact of relatively recent STEM initiatives in the USA to inform our understanding and encourage a more complex analytical discussion.

Elementary and secondary test scores and course taking

The latest NSF figures show gains in STEM test scores of elementary and secondary students, but not to the extent expected given the amount of resources and rhetoric that have been devoted to the effort for the past 10 years. Gaps between demographic groups persist although some have narrowed. White, Asian/Pacific Islander and middle-class students are still scoring higher than poorer students and/or African-American, Hispanic, and American Indian/Alaska Native students (National Science Board Report, 2012). Gender differences have certainly narrowed over time on standardized tests such as NAEP. On the 2006 and 2009 Programme for International Student Assessment (PISA) tests of 15-year-olds' math and science ability, US students still scored below students from many other developed countries though there was improvement in the USA from 2006 to 2009.

Although course taking in math and science has increased among high school students, including advanced courses, Hispanic and African-American students still earn the fewest advanced credits in both math and science (National Science Board Report, 2012). This is an important difference because earning credits in advanced math and science courses often leads to college majors in the STEM fields. Far more Asian/Pacific Islander students took advanced math, science, and engineering than any other group in 2009.

According to Hill, Corbett, and St. Rose (2010), girls and boys are doing pretty much equally well in math and science at high school. Girls are getting slightly higher grades than boys, but are taking about the same number of credits as boys. On high-stakes tests though, boys still do better than girls and boys take more AP exams in STEM-related subjects. When they transition to college, men major in the STEM fields much more often than women even though there are more women than men in college. The biggest disparity occurs in the engineering, computer science, and physical sciences where four times more men than women major. About 5% of women plan those majors as freshman compared to over 20% of men.

College and career trends

At about 60%, the national retention rates for men and women in these fields are about the same (Hill et al., 2010). However, since there were fewer women majors to begin with, the loss of women from these sciences is particularly troubling. Fortunately, a higher proportion of women are now graduating with bachelor's degrees in the STEM fields. In 2006, women were very well represented in biology and to a lesser extent in chemistry and math. But in physics, computer science, and engineering, women earned a much smaller proportion of bachelor's degrees. A slightly higher proportion of African-American and Hispanic women than men are earning bachelor's degrees in STEM fields although the overall representation of under-represented minority women in the physical sciences is extremely low.

However, since the late 1990s, women have earned approximately half of all science and engineering bachelor's degrees (National Science Board Report, 2012). Women are also earning much higher proportions of the STEM doctoral degrees than they were 40 years ago though they remain under-represented in all STEM disciplines other than biology (Hill et al., 2010). In 2009, African-Americans, Hispanics, and American Indians/Alaska Natives accounted for only 12% of students studying graduate science and engineering (National Science Board Report, 2012). The same report noted that there was no increase in the proportion of under-represented minority students earning master's degrees in science and engineering from 2000 to 2009.

In general, public secondary math and science teachers are better qualified than in the past (National Science Board Report, 2012). More than half had earned at least a master's degree and were fully certified in 2007. Disparities still exist in high-poverty schools though. Twenty-six percent of math teachers in high-poverty schools were alternatively certified compared to only 12% in low-poverty settings. And 69% of science teachers in low-poverty schools had advanced science degrees compared to 49% in high-poverty schools. Almost twice as many math and science teachers in high-minority schools were novices compared to low-minority schools.

It is interesting to note that the proportion of graduates in science and engineering who attended community college increased between 1999 and 2008 (National Science Board Report, 2012). Women graduates in STEM areas were more likely to have attended a community college than their male counterparts in 2008. Indeed, community colleges doubled in importance as bridges between high school and college in the form of dual enrollment programs from 1999 to 2008. The majority of under-represented minority science and engineering degree awardees attended community college along the way. Related to this is the fact that Black and Hispanic PhD students in STEM fields graduated with higher levels of debt than White students. Differing sources of support for graduate studies contribute to the picture. Under-represented minorities depend more on fellowships and traineeships than White and Asian students who received more Research Assistantships (RAs). Women were more likely to rely on personal sources of support than men, who were more likely to receive RAs.

The gradual increase of women and under-represented minorities majoring in science and math and earning graduate degrees in STEM fields has resulted in a small increase in women and under-represented minorities teaching in these disciplines at the elementary, secondary, and postsecondary levels. By 2003, women accounted for about 25% of full-time academics in science and engineering fields (National Academy of Sciences, 2010). STEM faculties at Research 1 institutions appear to be making a considerable effort to hire at least one woman. According to the 2010 figures, the percentage of women who were interviewed for tenure-track positions was higher than the percentage of women who applied, just as the percentage of first job offers to women was higher than the percentage of women who were invited to interview, except in biology. However, in all STEM areas, the percentage of women who applied for tenure-track positions was lower than the percentage of PhDs awarded to women in those areas. Moreover, despite an increase in numbers of women hired into STEM departments at the assistant professor level, the same proportion do not get tenure. This pattern is particularly disturbing in the two areas within which women are best represented: biology and chemistry.

Economic trends: career trajectories and job creation

Some researchers have come forward to point out that there is no clear connection between the math and science achievement of elementary and secondary students and economic growth. While education, economic growth, and quality of life are related, they are not related exactly in the way people assume. For example, higher test scores in STEM disciplines do not directly lead to creating more jobs, having a more globally competitive economy, or bolstering national standing. Rather, how much a country invests in research and development is a more accurate indicator of world competitiveness, mostly due to the potential for invention and patents (please see Anft, 2013; Feuer, 2011; Ramirez, 2007 for further details).

In addition to pointing out the above disconnect, some critics also have revealed the difficulty in pinning down what, precisely, a STEM job is:

> Who exactly is a STEM worker: somebody with a bachelor's degree or higher in a STEM discipline? Somebody whose job requires use of a STEM subject? What about someone who manages STEM workers? And which disciplines and industries fall under the STEM umbrella? Such definitions obviously affect the counts. (Charette, 2013)

According to Charette (2013), the NSF and the US Department of Commerce, amongst other groups, all define STEM jobs differently and use different metrics to count them. Overall, STEM workers are very broadly defined and make up less than 6% of the current US workforce (Anft, 2013).

In addition to difficulties identifying what counts as a STEM professional, there is also ample evidence arguing against the claims of a labor shortage in STEM fields (Anft, 2013; Charette, 2013). Rather, a counter-discourse exists that points to a surplus of lab workers and physical and life scientists in part due to universities' over-recruitment of science PhD candidates (Anft, 2013):

> There are more STEM workers than suitable jobs. One study found, for example, that wages for U.S. workers in computer and math fields have largely stagnated since 2000. Even as the Great Recession slowly recedes, STEM workers at every stage of the career pipeline, from freshly minted grads to mid- and late-career Ph.D.s, still struggle to find employment as many companies, including Boeing, IBM and Symantec continue to lay off thousands of STEM workers. (Charette, 2013)

Adding to that is the tendency of some reports (please see Georgetown University Center on Education and the Workforce: Carnevale, Smith, & Strohl, 2010) to claim the best way to get a job in our protracted, sluggish economy is to major in STEM fields. However, as Schalin (2012a) points out, the Georgetown report does not adequately explain that STEM graduates are not necessarily finding jobs in STEM fields. Rather, the Georgetown report includes all employment found by STEM graduates, not just jobs secured by STEM graduates in their particular field of study. This is not surprising when one considers data reported by the US Bureau of Labor Statistics, which indicate that the top 20 occupations with the highest projected numeric change in employment between 2010 and 2020 do not include jobs typically associated with STEM careers (see Table 1).

Table 1. New job growth projected for 2010–2020.

Occupation	Number of new jobs projected	2010 median annual pay
Registered nurses	711,900	$64,690
Retail salespersons	706,800	$20,670
Home health aides	706,300	$20,560
Personal care aides	607,000	$19,640
Office clerks, general	489,500	$26,610
Combined food preparation and serving workers	398,000	$17,950
Customer service representatives	338,400	$30,460
Heavy and tractor-trailer truck drivers	330,100	$37,770
Laborers, freight, stock, and material movers, hand	319,100	$23,460
Postsecondary teachers	305,700	$62,050
Nursing aides, orderlies, and attendants	302,000	$24,010
Childcare workers	262,000	$19,300
Bookkeeping, accounting, and auditing clerks	259,000	$34,030
Cashiers	250,200	$18,500
Elementary school teachers, except special education	248,800	$51,660
Receptionists and information clerks	248,500	$25,240
Janitors/cleaners, except maids, and housekeeping	246,400	$22,210
Landscaping and groundskeeping workers	240,800	$23,400
Sales reps, except technical and scientific products	223,400	$52,440
Construction laborers	212,400	$29,280

Source: US Bureau of Labor Statistics (2012a).

As Table 1 indicates, projections include jobs heavy in service orientation and low in pay such as janitors, cashiers, food service, and childcare workers. The only jobs that could be considered STEM-related include registered nurses, home health, and nursing aides. Even the category “sales representatives” does not include jobs that deal with technical and scientific products.

As Table 2 indicates, the US Bureau of Labor Statistics reports one of the fastest-growing occupations over the next 10 years includes bioengineers, whose median salary in 2010 was a little over $81K per year. However, also note that, following the prior pattern in Table 1, most job growth is projected for the health care industry. Importantly, the fastest-growing careers also include "helpers" from several labor categories such as brick masons, tile setters, carpenters, and pipefitters (please see Table 2). Meanwhile, companies such as Microsoft claim there is a shortage of qualified STEM workers to fill the spots of a growing STEM field, lobby for federal monies to be poured into public education to turn around failing schools and retrain incompetent teachers, and lobby for increasing the number of visas for foreign IT workers, while also laying off thousands of American workers with comparable skills (Anft, 2013; Charette, 2013). While some public schools and a portion of the teaching workforce do have deficits that need addressing, the strident rhetoric around the sorry state of STEM education leading to economic stagnation and loss of international standing does more to weaken morale and destabilize potentially valuable reform efforts than to create jobs (Feuer, 2011).

Table 2. Fastest growing occupations projected for 2010–2020.

Occupation	Growth rate (2010–2020, %)	2010 Median annual pay
Personal care aides	70	$19,640
Home health aides	69	$20,560
Biomedical engineers	62	$81,540
Helpers – brick/stone masons, tile /marble setters	60	$27,780
Helpers – carpenters	56	$25,760
Veterinary technologists and technicians	52	$29,710
Reinforcing iron and rebar workers	49	$38,430
Physical therapist assistants	46	$49,690
Helpers – pipelayers, plumbers, and steamfitters	45	$26,740
Meeting, convention, and event planners	44	$45,260
Diagnostic medical sonographers	44	$64,380
Occupational therapy assistants	43	$51,010
Physical therapist aides	43	$23,680
Glaziers	42	$36,640
Interpreters and translators	42	$43,300
Medical secretaries	41	$30,530
Market research analysts and marketing specialists	41	$60,570
Marriage and family therapists	41	$45,720
Brickmasons and blockmasons	41	$46,930
Physical therapists	39	$76,310

Source: US Bureau of Labor Statistics (2012b).

Analysis and interpretation

Critical examination of the federal discourse

Through the lens of FCPA, it is clear that for over a half-century, the federal government has propagated a STEM crisis. Over time, the discourse has been consistent in appealing to citizens' concerns that US schools and students are falling behind the rest of the world. The discourse has systematically rendered this perceived weakness in science, mathematics, engineering, and technology in highly aggressive terms – a type of "educational disarmament" – as a threat to national security during the Soviet Cold War era, and now as an economic threat to our survival as a superpower.

Over time, the war language subsided, but the quest to be "Number One" continues. The focus is on American economic power, not on individual student economic independence. Utilizing terms like "getting ahead of the pack" in federal and state reports and policy language can be interpreted as reinforcing the STEM crisis as a global race of winners and losers; not as a call to ensure individual children will enjoy learning, and also develop into economically stable adults who can care for their families and contribute to the overall well-being of society as engaged citizens of a democratic union. Further, there is no evidence that raising standards for elementary and secondary students directly leads to economic growth in the first place.

Additionally, President Obama's speech at the National Academy of Sciences where he called for a, "national campaign to raise American students 'from the middle to the top of the pack in science and math over the next decade'" (White House Brief, 2009) assumes all students' levels need to be raised, which research tells us is not necessarily true. Students in some demographic groups have consistently outperformed others over time. There is scant discussion of the achievement gap in terms of SES, race/ethnicity, and gender. The federal discourse concerning "reinvigorating the pipeline," as far as P-12 pathways for students, is centered on the pathway of innovation to contribute to American economic supremacy. We argue that there is a different pipeline that needs to be invigorated! The overall discussion assumes students do not take AP STEM coursework because they lack intelligence and/or interest. Our 75 years of combined experience tells us that most young people are capable and enthusiastic about science and math and the literature supports this. There is little discussion about how some students are not given the option to sign up and take these courses because they are not "tagged" by teachers to try the advanced courses. Or the fact that some students desire and attempt to take AP STEM coursework, but are not allowed to because they did not earn an "A" in the last course they took.

The latest national discourse does begin to address the importance of increasing women and minorities' access to more rigorous courses, but the solutions put forward overemphasize raising standards, using data to improve instruction, supporting teacher effectiveness, and turning around struggling schools. The implication is that these measures will ultimately make it possible for STEM experts to bring their experience and enthusiasm into schools and classrooms. The federal discourse suggests that we have to turn around struggling schools so that the *real* STEM professionals can do the true work. This is troubling. Acknowledging that "real change" can only occur with the involvement of "many elements of society" is great, but listing governors and business folk as a way to bolster community engagement is disrespectful of the many other local stakeholders who care about and know their students better: local school boards, pastors, parents, teachers, and principals. The cursory glance given to community engagement in the national discourse lacks depth and sincerity.

The most recent messages from the White House Council on Women and Girls start the conversation about removing stumbling blocks for women and girls as they navigate careers in STEM but this is work that is done once they are already there. Yes, there is a problem with retention, but what about getting them there in the first place? Additionally, the discourse lacks attention to the relative glut of low-paid, low-status STEM jobs often occupied by lab workers and physical and life scientists who are mostly women. At the same time, little emphasis is given to the importance of steering women and people of color to the higher-paying STEM careers that continue to show growth: engineering and software development (careers still dominated by white males). These contradictions need to be teased out further. Additionally, the White House Council on Women and Girls acknowledges the need to "increase engagement of girls," but what does this really mean? Does it mean trying to increase the interest of girls in STEM? Does it mean additional exposure? Again, our experience and the literature contend girls exhibit capability and interest in science and math at early ages, but are then socialized in different ways to dislike them or believe they are not capable in these fields. Doesn't increasing engagement really mean we need to train teachers in deficit thinking and culturally appropriate teaching?

The White House Council on Women and Girls also encourages mentoring. But how do we do this? If we know it is important, what are we going to do to bolster mentoring efforts? Additionally, the White House Council on Women and Girls acknowledges the importance of supporting efforts to retain women and minorities in STEM. But, there is a dearth of research that illuminates the successful implementation of retention programs. There is an overall lack of attention to detail concerning how to actually broaden and strengthen the STEM pipeline to include under-represented populations.

Critical examination of the state discourses

Similar to the federal discourse, the state discourses in California, Illinois, and Virginia make mention of the importance of increasing the number of students from "underrepresented" groups in the STEM pipeline, or "narrowing gaps" in science and math between students from under-represented groups and White students. However, most of the state discourses emphasize the STEM crisis in terms of increasing the overall number of students needing STEM training to fill labor demands and increase US economic competitiveness globally. The state discourses fail to capture the importance of increasing the breadth of participation to include women and minorities in particular. Focusing on numerical inputs and outputs is not enough. While Virginia begins to problematize the need to expand AP participation amongst females and minorities, none of the states examined adequately describe detailed plans that would facilitate structural changes or concrete changes in curriculum and instruction to prevent the "leak" in the STEM pipeline for under-represented groups. Thus, there is a lack of action to accompany the rhetoric. Further, it is questionable whether the states examined adequately define the problem in the first place.

The 2009 US Department of Education report, "Achievement Gaps: How Black and White Students in Public Schools Perform in Mathematics and Reading on the National Assessment of Educational Progress," recognized Virginia for narrowing achievement gaps between Black and White students in reading and mathematics. Given Virginia's success in narrowing the gap, it is surprising and disappointing that the 2009 report lacked specific details concerning strategies used in Virginia schools to narrow this gap.

Similarly, while the RTTT application paid specific attention to the strength of the proposals vis-à-vis expanding options for the general student population (with some attention to under-represented groups) to STEM literacy and knowledge, skills, and credentials that will prepare students for STEM careers, the application did not require specific plans for how states would go about increasing STEM participation for girls, racial minorities, or students of lower-SES status. As a result, each state has well-articulated plans for the scaling up of STEM, but this articulation is muddled (or non-existent) when it comes to specifics for under-represented groups.

Particularly disturbing is the discourse in Illinois that conveys under-represented groups as a threat to competitiveness. For example, the report on the Governor's Launch of the Illinois Pathways states:

> Over 60% of African American U.S. 12th graders are not math proficient and not interested in STEM; over 50% of Latino students are not math proficient and not interested in STEM, close to 30% of Asian American students are not proficient in math and interested in STEM, and close to 40% of White students are not proficient in math and interested in STEM. (IL DOCEO, 2012)

Illinois claims that if the state does not increase the skill development of under-represented groups, there will be drastic ramifications for the workforce and the state's standing in the national and global economy. However, the discourse clearly positions under-represented groups in deficit terms, claiming that students are either just not interested in STEM or lack proficiency or both (which we argue, further positions students as lacking the innate intelligence and inner drive to do so). Conversely, the public discourse in Illinois fails to adequately problematize what else might be causing the state's economic problems and fails to consider "symptoms" that may be causing the additional problems they fail to identify. The state is mute in terms of equity issues and their intersection with race, gender, and SES complexities. Rather, state indicators appear to measure and place the responsibility of societal problems on individual students, without problematizing societal (outside school) and cultural (inside school) structures that hinder student participation in STEM and whether supportive structures are in place to make sure students are college and career ready.

RTTT is the federal driver for STEM implementation at the state level, but currently, the language in the RTTT policy and application and in a similar vein the more recent NCLB waiver process does not consider gender in specific terms or the intersection of race, gender, language, ability, sexuality, and socioeconomic status. While Virginia acknowledged in its RTTT application that, "the needs of underrepresented groups and of women and girls in the areas of science, technology, engineering, and mathematics" must be addressed, there is no discussion as to how to do this or what exactly those "needs" are. For example, do these women need more mentoring than others? The research literature is not called upon nor are applicable steps outlined that the state of Virginia can take to identify and meet those needs.

There is minimal gendering of the state-level discourse, unless the assumption is that issues of gender are adequately addressed within the "underrepresented groups" category, which we argue are not. When a state does espouse supporting under-represented groups, it mainly focuses on racial disparities – not gender. (And in the case of Virginia, the discourse mentions gender only to point out that males are under-represented when compared to females in higher education arenas. While this is true overall, it is glaringly false when it comes to representation in STEM fields.) The state discourses fail to adequately capture the unique social justice needs of students caught at the intersection of race/ethnicity, class, and gender complexities.

Who are the real winners and losers?

As reviewed above, the STEM crisis rhetoric has persisted for more than half a century and is largely constructed by private and industry interests as well as federal and state policy rhetoric that ultimately influences local-level behaviors, decisions, and practices. Even though the monikers (such as NDEA, ESEA, NCLB, and RTTT) have varied over time, when critically examined through a FCPA lens, the discursive themes surrounding STEM remain the same. In the end, the rhetoric consistently promotes bureaucratic processes for advancement and innovation, offers competition as the only means to advance, and fails to fully recognize that it is not the *lack* of *skill* but rather the *lack* of social, economic, and educational *opportunities* that hinders advancement in STEM.

At this time, it seems there are two major industries that stand to win the most from the menacing rhetoric: the higher education arena and IT companies such as Microsoft. In terms of higher education, universities just plain need to fill seats and will recruit any way they can (Schalin, 2012b). Moreover, since universities receive about half the total federal STEM education budget of $3.1 billion, questioning the reality of the crisis discourse is a luxury that most state-funded institutions cannot afford (Anft, 2013). More troubling yet: not only does the IT industry stand to win by buying into the intimidating discourse; they seem to be some of those actually perpetuating it. Meanwhile, companies such as Microsoft are able to increase profits by hiring workers outside the USA and paying them less (Anft, 2013). The STEM crisis discourse adds fuel to the argument that teachers need supervision and that private business knows what is best for schools. While we recognize the importance of training a strong teacher workforce and providing ample opportunities for students to do well in school, we do not buy into the rhetoric that has persisted for more than half a century that teachers and schools are to blame for a stagnant economy. This unsubstantiated "teacher bashing" (Ramirez, 2007) and misplaced teacher criticism (Feuer, 2011) so present in the STEM crisis discourse works really well to tear educators (mostly women) down and put them in their place. Not only are their pride and autonomy at stake, but also their jobs.

In addition, students and parents stand to lose in the current political climate. The grading and public shaming of neighborhood schools and teachers leads to school closures and the disintegration of communities. The true nature of the crisis in this country is masked by the current rhetoric. Rather than adequately addressing poverty, unequal school finance, and segregated schooling experiences, students are fed false promises about guaranteed jobs and high salaries if they will only try harder, do better, and take more courses in math and science. Moreover, the public at large loses. Policy and practice in democratic nations should not be driven by unsubstantiated scare tactics and silver bullet claims. For example, if educators are required by NCLB to implement research-based policies and practices, then these same standards should apply to industries and special interest groups pushing these sweeping, expensive changes. We agree with Barias (2006) that we cannot afford to be pouring billions of dollars into programs based on rhetoric, especially considering the large federal deficit. This seems especially fitting in light of recent government shutdowns.

Discussion and recommendations: reframing the discourse

Our analysis thus far has provided us with many insights. In addition to troubling the policy discourse in terms of its substance and tone (Feuer, 2011), and perpetuated social and nationalistic biases (Charette, 2013), we have come to question the claims that there is a shortage of STEM professionals to fill growing job opportunities along with doubting the argument that national economic power is directly related to how well elementary and secondary students perform on achievement tests. In addition to surfacing these concerns, we will also bring to the fore feminist concerns that were raised decades ago and subsequently cast into the shadows as the crisis rhetoric took center stage.

Therefore, the purpose of this section is to answer the call of Marshall (1997) who asks us to replace the inadequate theoretical and political lenses governing traditional policy analysis with those that will yield more complex questions and more nuanced understandings. In her feminist critique of school violence policies, Marshall pointed out, “Policymakers focus on the guns-and-knives school violence but do not include sexual harassment as a school violence issue” (p. 1). We argue similarly – that the STEM crisis discourse is curiously silent on dismantling the philosophical and structural gridlocks that hold girls and women back despite policy rhetoric that claims to meet their needs. Marshall goes on to ask: “Can our policy literatures change this? Can critical and feminist theory reframe the policy world?” (p. 1). We proclaim an emphatic, “Yes!” We wish to push the discussion forward by uncovering and upsetting current systems of dominance. It is beyond the scope of this paper to give more than brief treatment to just three of these systems that need to be problematized: the history of Western thinking and the sciences; schooling practices that contribute to the STEM problem; and the constraints of modern bureaucracy and hierarchical arrangements.

Western knowledge and science

Feminist researchers have challenged the intellectual and social foundations of scientific thought and have criticized traditional Western knowledge and science discourse as being male-dominated, uncovering the ways in which power inequities are created and/or reinforced in the sciences, academia, and society at large while also debating how the role of gender and/or feminist values are ignored in the scientific enterprise (please see Harding, 1986, 2006; Lather, 1991; Parker, 1997). Harding (2006) goes further, arguing that scientific endeavors, far from their earlier enlightenment mission, currently reflect andocentric values, such as competition, that bolster militaristic aims and contribute to Western expansion and environmental destruction (not to mention the pseudoscience that has been used cyclically for generations to equate lower intelligence and/or lack of reasoning skills of human beings that happen to be women, poor, Black, or all of the above).

The STEM crisis discourse continues to reinforce our cultural psyche that equates Western knowledge and sciences with the rational, European male. The policy dialogue is sorely lacking the feminist critique, along with recommendations or policy options that address overhauling our cultural understandings in this regard. Whether intentional or not, the complicity of the sciences with undemocratic practices must be a part of problem definition and resolution. In fact, Harding

(2006) insists that scientists, policy-makers, and everyday people as scientific consumers, can work alone, and in concert, to make needed changes. Science, however historically constituted in Western, capitalist masculinity, can be used in the future for social justice ends (Harding, 1986). However, we argue it will take more than just giving in to the "Me, too!" feminisms (see Ferguson, 1993; Lorde, 1984) that demand opportunity, and further still, must go beyond providing compensatory programs aimed at women and minorities for them to better "cope" or "fit" in STEM departments (Stage, 1997; Win & Wilson, 1997) to transform institutions (Ferguson, 1984; Marshall, 1997).

Schooling the gendered, raced, and classed body

Moreover, when speaking of institutions that need transforming, it is assumed that "schools are apolitical sites where identity-less students gather, absorb the same information, and share the same opportunities to succeed" (Adams, 1997, p. 153). Governments – and their envoys, schools – continue to disadvantage girls and women in general (Marshall, 1997; Weiss, 1997; Win & Wilson, 1997) and poor and/or racial/ethnic minority students in particular because, "it is now recognized that the experience of particular groups of girls and women is deeply influenced by their differing material and cultural circumstances; [so] that to look at gender alone is insufficient and inadequate" (Win & Wilson, 1997, p. 239).

Researchers have concurred that identity markers such as socioeconomic status, race, gender, and religion are related to educational and vocational access and achievement (Cammarota, 2008; Irizarry, 2011; Jean-Marie & Mansfield, 2013; Mansfield, 2008; Mansfield & Newcomb, 2014; Mansfield, Welton, & Lee, 2011; Mansfield, Welton, Lee, & Young, 2010; Valencia, 1997). As Walker (2006) so eloquently observed: people's levels of access and achievement differ along their "personal axis" (e.g. gender and age), "environmental axis" (e.g. wealth and climate), and "social axis," which entails people's ability to convert resources into valued outcomes (p. 166). We argue along with Adams (1997) that, for human growth and development, classroom space and time must be pre-arranged to examine "the contradictions, tensions and ambiguities embedded in the multiple intersections of identity" (p. 159). We believe that if educational professionals engage in conversations that trouble over students' ability to convert their personal, environmental, and social affiliations into valuable commodities, they will be better facilitators of learning. This theoretical construct suggests that it is essential to acknowledge the import of intersecting identities as well as the significance of personal agency and other attributes that influence the degree to which a person can reach her/his capability and potential (Walker, 2006; Yates, 1997).

Bureaucracy and hierarchy

Finally, but not exhaustively, schools, universities, and fields of study are bureaucratic and hierarchical: a feminist point of contention that is not mentioned in the STEM policy discourse that we begin to trouble here. We argue that patterns of power, control, dominance, and subordination are firmly enmeshed in modern life via the bureaucratization of public life, coinciding, not accidentally, with substantial economic and technological changes that have occurred since the mid-twentieth century (Ferguson, 1984). Feminists argue that rather than being essential to achieving important organizational goals, hierarchical patterns of authority preserve the status quo that is, in fact, restrictive of human growth and development and technological progress (Ferguson, 1984). Moreover, bureaucracies tend to invent and reify their own language and procedures to maintain control over people and other resources. Since bureaucratic operations are "one-directional, in that it is difficult to 'talk back,' [and] acausal, in that it is difficult to find out where the directives originated and who is responsible for them" (Ferguson, 1984, p. 15), negotiation and compromise are thwarted and change is negated. Further, in order to engage in change-agent behavior, "one must first penetrate the façade of ideological neutrality that administrative structures claim for themselves and see them as political arenas in which domination, manipulation, and the denial of conflict are standard operating procedures" (p. 17). In addition to this is the likelihood that the oppressed are expected to be the ones to "stretch out and bridge the gap" between their lived experiences in organizations and the "consciousness" of those in power. "In other words, it is the responsibility of the oppressed to teach the oppressors their mistakes" (Lorde, 1984, p. 114). Gilligan (1982/1993) would argue that "this hierarchical ordering, with its imagery of winning and losing" accompanied by impending hostility, situates human beings in general, and women in particular, in destructive, lose–lose situations that cannot be reconciled morally or ethically. Until organizations couple an "ethic of justice" (equality) with the "ethic of care" (constructive), all people will be severely limited in their ability to transform school and work life (Gilligan, 1982/1993).

Conclusion

Following Marshall's (1997) recommendation to reconstruct STEM policy analysis using FCPA, we conclude that opportunities for women and minoritized others remain either unchanged or further restricted as a result of the initiatives taken thus far to address what is perceived as a severe national deficit in the STEM fields. To understand this situation more fully, we advocate for more accurate communication of the true nature of job and wage growth and stagnation. We encourage researchers using other critical policy frameworks to investigate further into who might be perpetuating the current discourse and to identify clearly who emerge as winners and losers. We found it also important to re-center prior feminist knowledge that has taken a back seat to the current discourse based on nationalistic fears.

Our application of FCPA reveals that the STEM discourse is void of problem definition and solutions that consider more complex, multifaceted explanations centered on equity and justice. The problem is largely defined by one-sided arguments driven by self-interests and capitalistic/economic rationales. Almost 20 years ago, Berliner and Biddle (1995) offered similar critique of government and industry leaders' general attack on American education. The authors demonstrated how a negative spin was generated by an "assortment of questionable techniques – including misleading methods for analyzing data, distorting reports of findings, and suppressing contradictory evidence" (p. 4). We argue in similar vein: that purveyors of the STEM crisis discourse use similar tactics. Thus, given the reproductive and unchanging state of affairs, we emphasize that future discourse around STEM should include a critique of bureaucracy and the history of Western thinking and science that privileges the rational, Anglo male, as well as interrogate the intersection of educational opportunity and access, student identities, educator beliefs, and educational policy and practice. We seek recommendations for how to dismantle and rebuild both material and philosophical institutions that welcome and honor the multitude of humanity that holds promise to move the STEM field forward for the global common good.

Finally, we underscore the utility of utilizing critical policy analysis (CPA) in educational research endeavors. Using a feminist CPA frame enabled us to deconstruct the policy discourse by: paying attention to how the "problem" is framed, recognizing who benefits from the way the problem is framed and by the way(s) it is being addressed, and listening to counter-narratives that flesh out the effects of policy on women and minoritized others; particularly, those at the intersections of multiple identity complexities such as race, socioeconomic status, and gender, to name a few. In addition, as Marshall (1997) argues, including a feminist perspective helps "correct the over determinism of critical theory by rediscovering human agency" (p. 18). This allows us to pay attention to the social, economic, and political structures that position individuals differentially, while at the same time prompting us to explore ways to resist and renegotiate the subjectification of women and minoritized others who are thought of as needing to be "fixed" in order that the problem might go away.

Notes on contributors

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